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III. Customs and superstitions in regard to certain products, as rice, wheat, and corn: rice, for instance, has been planted yearly by the emperors of China since 2500 B. C.; it is used in sacrifice to appease deity during eclipse, and in exchange of compliments in oriental diplomatic circles.

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References on irrigation: *Year-Book of the Department of Agriculture*, 1895, p. 482; King, "Irrigation," *The Soil*, pp. 75, 268; Marsh, "Irrigation," *The Earth*, pp. 67, 448; Liebig, "Effect of Irrigation on Injurious Organic Matter," *Modern Agriculture;* Murray, "Irrigation in Egypt," *Handbook*, *Egypt*, p. 47; "Drainage and Irrigation," *Iconographic Dictionary*, pp. 32, 323.

APPLIED MATHEMATICS.

GEORGE W. MYERS.

THE TEACHING OF ARITHMETIC.

MANY schoolmasters seem quite certain that most of the troubles which afflict school work have their root in arithmetic. The basis of their certainty is not sufficiently clear, however, to carry conviction to the minds of those hard-headed, practical men whose contact with affairs leads them to look upon school work as a serious matter for those pupils who have their place in life to make and to hold. To such persons education means much more than the devising of a system for exemplifying, or even *verifying*, pedagogical tenets. Fortunately for all of us, there is always one or more of such "troublesome fellows" in an important official relation to the school system of nearly every community.

If it were not for this fact, it can scarcely be doubted that the mathematical subjects would have fallen out of the curricula long ago. These subjects are rarely upon the program of instruction because the superintendent or the teacher would have them there. It is so much more agreeable, generally, to have to do with subjects which deal with opinions, or with more or less plausible vagaries and generalities, where there are no easy means of testing thought-processes, and where it matters little whether the view advocated is correct, that, if most teachers — especially elementary teachers — could have their way, they would relegate these more exacting subjects to the limbo of the educationally useless.

Many of the theories which the self-styled reformers in education have advocated to render palatable the mathematical pill have coated the distasteful morsel so thickly with what they regard as wholesome that there is really none of the remedial virtue left. Correlation, as commonly conceived, which simply eliminates every demand for pointed and clear-cut thinking and speaking, concreting number in such wise as to concrete out every mental act allied to numbering, belongs to this category of theoretical dodges of number-teaching. These and all similar *devices*, not for teaching, but for dodging number, last their little day — serve, in fact, the function they were devised to serve, viz., lift their inventors to prominence and profitable places — then pass away of their own inherent dearth of vitality.

Then, following closely upon the failure of the number panacea, comes a stentorian voice from without, demanding that the youth be instructed in the rudiments of those subjects without which success in life is impossible. The laiety now have their day, until some ingenious pedagogue shall revamp an old device and invent a new name for it; then the love of schoolmen for catch-phrases will again for a time triumph; and so on *ad infinitum.*

In the midst of all this it is well to keep in mind that artifices and artificial subject-matter are continually accumulating, and that real difficulties are being relegated to the background, while artificial difficulties mount into prominence.

About the only inference which may now be safely drawn from the mathematical situation is that teachers do not determine whether they will teach arithmetic. They may exercise some measure of choice as to manner and matter, but very little as to whether or not it shall be upon the program of instruction.

The reason for this limitation upon the teacher's power to dispose over this subject lies in the fact that there is a necessity in the nature of things that the mind shall view them under a number aspect. This necessity has its roots in two facts. The first is that there is a multiplicity of existing things and relations of things; and the second, that the human mind, while desirous of knowing, is greatly limited in its power to comprehend truths not clearly perceived and related. So long as this desire clings to the mind of man, and he must seek means of economizing his capabilities, so long will it be necessary for the unwilling teacher to disturb his mental peace with the question of better mathematical teaching.

OUTLINE OF WORK FOR JANUARY.

I. Number-teaching in the kindergarten.

II. Reasons for teaching number in the primary grades. (1) Educational reasons; (2) practical reasons.

III. Extent of the number-teaching in the primary grades. (1) First year: development of numbers to 12. (2) Second year: number "building" through "parting and wholing" of numbers to 30 or upward. (3) Third year: factors of numbers to 144 for use in teaching tables, and some effort to render operations automatic. (4) Fourth year: mastery of four fundamental operations; some number generalizations.

IV. Subject-matter by which this is to be accomplished. (1) The pupil's needs and interests as determining factors. (2) The environment as a determining factor. (3) The other subjects as determining factors. (4) Insight and alertness of the teacher as a factor.

V. Preliminary work. (1) The number concept is a growth; it cannot be manufactured. (2) Comparison—indefinite and definite. (3) Measurement—direct and indirect—of (*a*) lines; (*b*) surfaces; (*c*) solids; (*d*) weights; etc. (4) Counting. (5) Construction.

VI. Original problems. (1) Outdoor work: (*a*) in measurement; (*b*) in geometrical construction on the ground. (2) Paper-folding and paper-cutting.

VII. Number work in nature study, in geography, in art, etc. (1) To be number work, the number concept must be the most prominent thing in consciousness. (2) *Routine drill* without the conscious exercise of the numbering faculty is harmful. (3) Too much repetition of a few simple and familiar operations is the danger of incidental number-teaching.

VIII. Preparation of the teacher for the number lesson.

IX. Preparation of number plans for the grades.